1,171,201

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,171,201

Date of Application (No. 5621/67) and filing Complete Specification: 6 Feb., 1967.

Application made in United States of America (No. 536,406) on 22 March, 1966.

Complete Specification Published: 19 Nov., 1969.

Index at acceptance:—E1 F44; F2 G30

International Classification:—E 21 b 33/04

COMPLETE SPECIFICATION

Well-Heads having Adjustable Hanger Retainer Assemblies

We, GRAY TOOL COMPANY, a Corporation of Texas, United States of America of 7135 Ardmore Street, Houston 1, Texas, United States of America do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to well-heads and more particularly to a well-head having an adjustable hanger retainer assembly.

In petroleum well completion technology the use of hold-down means to prevent or at least restrain the upward movement of hung elements, such as casing, tubing and associated hangers with respect to the well head and/or adjacent next-outer casing, casing head hanger seats and the like, has become quite usual, primarily to ensure that seals between well head parts are not interrupted and also to forestall upward movement of hung elements due to surges of subterranean pressure incumbent on such elements.

One type of prior art hold-down means comprises locking screws which threadably extend through side apertures in a well head, each screw having a conical or wedge-like nose portion for engaging in a peripheral groove in a hanger or against a tapered surface on the upper end of the hanger to be held down. An example of this type is shown in the U.S. patent to Davidson, No. 2,507,246.

Particularly where a head assembly for receiving a plurality of casing and/or tubing hangers is used during the course of drilling and completion of a well, and locking screws of the type just referred to used to hold lower hangers down, the heavy drilling equipment attached to the top of the head tends to drive the locking screws through the tops of the hangers as the surface casing on which the head is mounted moves down under constant drilling vibration.

There is one means being successfully used to prevent such damage to hangers, yet provide positive hold-down means. In that instance, a snap ring is received in a peripheral groove in a hanger and held in contracted condition by a tool received axially within the well head bore, until such time as the hanger is properly positioned with respect to a seat in the head, whereupon the tool is manipulated to allow the snap ring to self-expand into locking engagement with an inner peripheral groove in the head.

For various reasons including facilitating the performance of certain work-over techniques, examination to locate the reason for malfunctions, adjustment to meet changed conditions and in temporarily or permanently abandoning wells, it is advantageous to provide for unlocking of such hangers with respect to the heads in which they are received.

Accordingly, it is a primary object of the present invention to provide, in a well-head, hanger hold-down means having the bearing strength advantages of snap-ring type hold-down means, but which are easily adjustable exteriorly of the well-sead both during and subsequent to completion of the well.

A further object of the invention is the provision, in a well-head, of an internally grooved, split-ring type hanger retainer which is self-aligned with respect to the hanger to be retained during the locking operation.

A more general object of the invention is to provide, in a well-head, a hanger retainer of the type described which has broad applicability to provide, supplement or substitute for lock-down assemblies for the hanger assemblies shown in the following U.S. patents: Mueller, 2,157,964, May 9, 1939; Brown, 2,189,575, February 6, 1940; Roye, 2,207,469, July 9, 1940; Yancey, 2,207,471, July 9, 1940; Lemley et al, 2,485,497, October 18, 1949; Crain, 2,586,581, September 18, 1951; Mueller et al, 2,624,413, January 6, 1953; Watts et al, 2,751,235, June 19, 1956; Watts et al, 2,754,134, July 10, 1956; Watts et al, 3,001,803, September 26, 1961; Watts

[*Price 4s. 6d.*]

et al, 3,051,513, August 28, 1962, and in the Composite Catalogue of Oil Field Equipment and Services, 1966—67 Edition, Gulf Publishing Co., Houston, Texas, Volume 2, page 2065, Figure 11; page 2074, Figures 35 and 36; page 2075, Figures 37 and 38; page 2080, Figures 52 and 53; page 2081, Figures 54, 55 and 57; page 2085, Figure 63; page 2086, Figures 65, 66 and 67 and page 2087, Figure 68, these examples intended to be non-limitative illustrations of the scope of applicability of the present invention.

It is a still further object of the invention to provide, in a well-head, an adjustable hanger retainer assembly which includes a contractile ring, initially received in a free, expanded condition in a peripheral groove in a casing head or the like, means received in the casing head and operable exteriorly thereof to reversibly, forcibly contract the ring into locking engagement with a casing hanger or the like in order to restrain upward movement of the anger to within a predetermined amount.

These, as well as further objects of the invention, the principles and scope of applicability thereof, will become more clearly apparent during the course of the following detailed discussion related to the embodiments illustrated in the annexed drawings.

In the Drawings

Figure 1 is a side elevation view, with adjacent parts removed, of a well head employing two hanger retainers according to the present invention. Some well head elements, including the compact casing head casing hangers, parent tubing hanger, wedges and retainer rings are partly broken away to expose details that would otherwise be hidden from view. In the view, the ring compressor and wedge operator screws are shown extending parallel to the viewing plane, somewhat out of angular position, for clarity.

Figure 2 is an enlarged fragmentary sectional view taken substantially along line 2—2 of Figure 1;

Figure 3 is a top plan view of the retainer ring shown in Figures 1 and 2;

Figure 4 is a fragmentary longitudinal, sectional view of a head, retainer ring and hanger according to the present invention, the retainer ring being in the free, expanded condition thereof, resting in the head inner peripheral groove;

Figure 5 is a fragmentary longitudinal sectional view, similar to Figure 4, of the ring in a forcibly contracted, hanger retaining condition; and

Figure 6 is a fragmentary longitudinal sectional view, similar to Figure 5, of a modified embodiment.

In Figure 1, the unitary casing head 10 is shown flanged at 12, 14 for mounting on the upper ends of outer casing 16, 18, for instance by welding at 20. A longitudinal throughbore 22 is formed through the casing head and is provided with an upwardly facing, frustoconical annular seat 24 near the lower end thereof. In the embodiment shown, on two levels above the seat 24, the head 10 is provided with a plurality of radially directed side outlets 26 that communicate the throughbore 22 with the exterior of the head. Just below the two levels of side outlets, the head 10 is provided with radially directed annular protrusions 28 for mounting ring compressor screws. Preferably, several protrusions 28 are provided on each level, for instance three or more equi-angularly spaced from one another.

Above the upper level of protrusions 28, and in the same plane as the upper level of side outlets 26, the head 10 is shown provided with wedge receiving ports 30, one of for instance four, being shown. The head 10 in the illustrated embodiment terminates in a radially directed annular flange 32 having vertical bolt holes 34 equi-angularly spaced around it to provide for the securement and sealing of a blowout preventor stack (not shown) to the head via bolts (not shown) and an A.P.I. ring received in the groove 36 during intermediate stages of the drilling of the well, and for mounting a tubing bonnet and various conventional surmounting Christmas tree parts during completion. As should be apparent other securement and sealing means than the bolted flange and A.P.I. ring just described could be substituted, the deflectable lip sealing ring and clamp assemblies of the U.S. patents to Watts 2,766,829, 2,766,998, 2,766,999, 3,181,901, 3,216,746 and 3,231,297 being particularly useful in such an environment.

As shown in Figure 1, the flange 32 has a plurality, for instance 16, equi-angularly spaced, radially directed threaded openings 38 therethrough for receiving means for locking a parent tubing hanger in place.

Having reference to Figures 1—5, it should be noticed that the protrusions 28 have bores 40 which intersect the head 10 throughbore at their radially inner ends and respectively terminate in a lower internal peripheral groove 42 and an upper internal peripheral groove 44. Each groove 42, 44 extends 360 degrees about the head throughbore in the embodiment shown and has a radially outwardly directed slot 46 whose purpose will be more fully described hereinafter. A split "C" ring 48, 50 is received in each groove 42, 44 by compressing the ring, placing it in the throughbore 22 and allowing it to expand. Preferrably, the radial depth of the grooves 42, 44 and free internal diameter of the rings 48, 50 when positioned as shown in Figure 4, is such that the rings do not protrude so significantly into the full opening of the throughbore 22 that equipment can damage them, be damaged by them or become snagged by them. Each retainer ring 48, 50 at one end thereof, has an integral, radially outwardly directed tang 52

configured to fit in the slot 46 in its respective groove 42, 44 in order to prevent rotation of the ring and reduce the number of ring compressor screws effectively needed to force radial contraction of the rings 48, 50. It should now be noticed that the rings 48, 50 are internally threaded at 54 and have a smooth radially outer surface 56.

The ring compressor screw receiving bores 40 are counterbored at 58 leading to the radially outer extents of the bores 40 and internally threaded at 60 adjacent the bore radially inner extent and at 62 adjacent the counterbore radially outer extent. Each ring compressor screw 64 comprises an elongated rod having a substantially flat inner end 66, an enlarged axially short exteriorly threaded region 68 adjacent the end 66, a short region 70 of reduced diameter defining an annular radially inwardly facing shoulder 72, and non-circular means 74 near the radially outer end for receiving a screw turning tool. Each screw 64 is threadably advanceable and retractable in its bore 40 via interengagement at 60, 68 and supported and sealed in its bore 40 by hydraulic packing or the like 76 received between annular washer-like elements 78 that serve as packing retainers and bearings, the innermost abutting the shoulder 72 and the shoulder 80 defined at the radially inner extent of the respective counterbore 58. The elements 76, 78 are retained by a packing gland nut 82 threadably received at 62.

After the head 10 has been mounted on the outer casings as shown in Figure 1, drilling to prepare for the next inner casing string 84 is conducted through the head 10 throughbore 22. When sufficient hole has been made, the casing string 84 is made up and run into the hole. A casing hanger 86 is secured to the upper end of the last section for instance by circumferential welding at 88 and lowered into the head throughbore using a lowering nipple (not shown) removably secured to the hanger 86 internal threads 90. In the embodiment of Figures 1—5, the hanger 86 has a downwardly facing, upwardly enlarging annular shoulder 92 by which it is supported on the casing head seat 24. Above the shoulder 92, the hanger 86 has a generally cylindrical exterior surface 94 peripherally grooved to receive hydraulic packing rings 96 which seal against the cylindrical bore 22. An integral, axially upwardly directed annular extension 98 of the hanger 86 is provided with exterior threads 100 complementary to the retainer ring internal threads, but of somewhat greater axial extent. Above the threads 100, the extension 98 is ported at 102 radially adjacent the lower level of side outlets 26 to provide communication through the side outlets 26 and ports 102 with the bore 104 of the casing string 84. The extension 98 is provided with a substantially flat upper end 106. After the casing hanger 86 has been landed with respect to the head 10, the hanger external threads 100 are adjacent but radially spaced from the retainer ring 48 internal threads 54 as shown in Figure 4. Next the ring compressor screws 64 abutting the smooth rear face of the retainer ring 48 are threaded inwardly forcing radial contraction of the ring 48 to the condition depicted in Figure 5 wherein the threads 54 and 100 are interengaged. Preferably, damage to the threads 54 and 100 is prevented and proper engagement ensured by using coarse threading, for instance about one-half thread per inch and by making each retainer ring receiving groove 42, 44 of slightly greater height than the pitch of the threads. In addition, alignment is aided in the Figures 1—5 embodiment by cutting the threads 54, 100 in a non-spiral i.e. circumferential, annular fashion. By comparing Figures 4 and 5, it should be apparent that these provisions ensure self-alignment of the retainer ring as it is being forcibly contracted. It should also be noticed that because the ring receiving groove 42 is of greater axial extent than the ring 48 and because the ring 48 smooth radially outer surface is only abutted by the smooth noses of the ring compressor screws, the ring 48 can move axially to effect alignment during forced contraction thereof (compare Figures 4 and 5), and thereafter a limited amount of axial movement of the ring 48 casing string 84 and casing hanger 86 can take place, such movement being limited in axial extent to the magnitude of the difference between the axial height of the groove 42 and the axial height of the ring 48 since the ring upper and lower surfaces 107, 108 are partly radially coextensive with the groove 42 even when the ring is forcibly contracted to the Figure 5 position thereof.

In the embodiment shown in Figures 1—5, such limited axial movement does not disturb the sealing between the hanger 86 and head throughbore 22 since this sealing is between cylindrical surfaces as described above.

After the casing string 84 and hanger 86 have been run and the ring 48 forcibly contracted, drilling through the casing string 84 bore is commenced in preparation for running the next inner casing. (The various casings can be cemented after being run using conventional techniques). When sufficient hole has been made, the next inner casing string 109 is made up and run into the hole. A casing hanger 110 is secured to the upper end of the last section for instance by circumferential welding at 112 and lowered into the head 10 throughbore 22 using a lowering bushing (not shown) removably secured to the hanger 110 internal threads at 114. In the embodiment of Figures 1—5, the hanger 110 has an annular, downwardly facing lower shoulder 116 by which it is supported on the upper end of the hanger 86 extension. The hanger 110 is provided with exterior threads 177, and hydraulic

packing rings 120 substantially equivalent to the threads 100 and rings 96. Using the procedure outlined above, the retainer ring 48 is brought from a position corresponding to that shown in Figure 4 to one corresponding to that shown in Figure 5.

After conducting further conventional downhole well completion operations that will be apparent to those skilled in petroleum well technology, the well head is further made up by installing a parent tubing hanger 118, the particular example shown being equipped for receiving two tubing hangers (not shown) side by side for supporting two tubing strings, for instance to allow production from separate zones in the well to be segregated as is well known in the art. The parent hanger 118 is shown supported on the flat supporting surfaces 121 of wedges 122 and held down by conventional set screws received in a circumferential groove 124. Near the upper end of the head 10 throughbore 22, a flared sealing surface 126 is formed and against which the sealing ring in flared lip 128 of the parent hanger 118 seals. No substantial weight of the parent hanger 118 is borne by the surface 126, almost the entire support being provided by the wedges 122 at 121. After the blowout preventer stack (not shown) has been removed from the upper end of the head 10, a conventional tubing bonnet can be secured to the head 10 upper end and usual Christmas tree elements emplaced.

If for any reason, it becomes desirable to free the hangers 86 and/or 110 it is only necessary to thread outwardly the respective ring compressor screws sufficiently to allow the respective ring 48, 50 to self-expand into its groove 42, 44.

A modified embodiment is depicted in Figure 6 wherein the casing head 10′ throughbore 22′ primary sealing surface 130 is frustoconical rather than cylindrically curved. Accordingly, it is necessary to hold the hanger 86′ complementarily curved sealing surface 132 and seals 134 down against the sealing surface 130. This is accomplished by providing buttress threading 54′, 100′ on the split retainer ring 48′ and hanger 86′ respectively. As the ring 48′ is forced from a condition comparing to that of the ring in Figure 4 to one comparing to that of the ring in Figure 5, the ring 48′ is forced to rise in its groove and if turned in sufficiently will abut the groove upper surface as shown, the downward wedging action of buttress threads and the fact that the compressor screws positively prevent the ring from expanding so long as they are turned in ensures that the seal at 130—134 will not be unintentionally disturbed. In other material respects the construction shown in Figure 6 is identical to that of Figures 1—5.

As with the Figures 1—5 embodiment wherein Vee threads 54, 100 are shown, the buttress threads 54, 100 can be spiralled as an alternative to being non-spiralled, circumferential as shown. Self-alignment of the threads 54, 100 and 54′, 100′ when the threads are of the spiral type can be facilitated by interposing a soft rubber ring between the bottom of the respective retainer ring and the lower surface of the respective groove in order to support the respective ring, when in a free, expanded condition, spaced axially intermediate its groove so that the ring can move either upwardly or downwardly in order to properly align with the complementary casing hanger grooves.

It should be apparent that the relative vertical sliding between the ring compressor screw noses and the retainer ring radially outer surface which usually occurs as the screws are threaded in and the ring begins to self align with the casing hanger threading, does not necessitate that the screw noses not be secured in any manner to the ring. For instance, the screw noses could be upset or enlarged relative to the shanks and the noses received in undercut keyways in the ring outer surface so as to allow relative vertical movement of the screws and rings as wellas radial expansion and contraction of the ring.

WHAT WE CLAIM IS:—

1. A well-head having an adjustable hanger retainer assembly including a first part comprising a casing head having a generally cylindrical bore with a circumferential groove therein opening radially inwards, a second part comprising a casing hanger axially received in said bore and having securing means thereon generally opposite said groove, a generally C-shaped contractible ring received in said groove free, in its normal expanded condition, of said second part and having co-operating securing means thereon for engaging said first-mentioned securing means and contracting means forming part of said assembly for reversibly forcing said ring radially inwards to project part-way out of said groove and into said bore and thus to bring the co-operating securing means into co-operating engagement with the first-mentioned securing means.

2. A well-head according to claim 1, wherein an upwardly-facing seat is provided within the bore of said casing head and a downwardly-facing shoulder is provided on said casing hanger, the shoulder abutting said seat thereby to support the hanger on the head and the assembly additionally includes circumferential sealing means between said casing head bore and said casing hanger to provide a fluid-tight seal therebetween.

3. A well-head according to claim 1 or claim 2, wherein said first-mentioned securing means and said co-operating securing means are co-operating threads.

4. A well-head according to claim 3, wherein the threads are non-spiral, circumferential threads.

5. A well-head according to any of claim 3, wherein the threads are spiral threads.

6. A well-head according to any one of claims 3 to 5, wherein the axial extent of said groove is greater than the axial extent of said ring by an amount which is at least slightly greater than the pitch of said threads.

7. A well-head according to claim 2, wherein said sealing means comprise an upwardly-facing and upwardly-enlarging frusto-conical surface in said bore of said casing head and a downwardly-facing, downwardly-reducing frusto-conical surface on said casing hanger, said last mentioned surface having at least one circumferential recess therein, and packing material received in said recess and extending outwardly for engagement with the frusto-conical surface of the casing head and wherein said first-mentioned securing means and said co-operating securing means are buttress threads constructed and arranged forcibly to resist movement of the frusto-conical surface of the acsing hanger upwardly and away from said frusto-conical surface of the casing head.

8. A well-head according to any one of the preceding claims, wherein the contracting means comprise a plurality of radially-directed ports through said first part communicating at the radially inner ends thereof with said grooves and, movably mounted in each of said ports for advance and retraction therein, elongate elements.

9. A well-head according to claim 8, wherein the elongate elements are threadably received in the respective ports and have outer ends which protrude externally of the first part and wherein means to co-operate with a turning tool are formed on the outer ends of each of the elements.

10. A well-head according to any one of the preceding claims, wherein said casing head is mounted and supported on the upper end of a surface casing received in the earth whereby said ring is prevented from damaging said casing hanger during subsequent drilling operations which vibrate said surface casing due to the limited axial mobility of said ring.

11. A well-head according to any one of the preceding claims further comprising a radially-directed tang on said ring adjacent one end thereof and a complementary radially-directed recess opening into said first part from said groove, the tang being received in the recess.

12. A well-head according to any one of the preceding claims further comprising a casing string secured to and depending from said casing hanger, a second casing hanger received within said bore and supported on the first mentioned casing hanger, a second casing string secured to and depending from said second casing hanger through said first casing hanger and into said first casing string, said second casing hanger being retained within said bore by an assembly according to any of claims 2 to 12.

13. A well-head substantially as hereinbefore described with reference to Figures 1 to 5 or Figure 6 of the accompanying drawings.

BREWER & SON,
Chartered Patent Agents,
5/9 Quality Court,
Chancery Lane, London W.C.2.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa. 1969.
Published by the Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

1171201 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

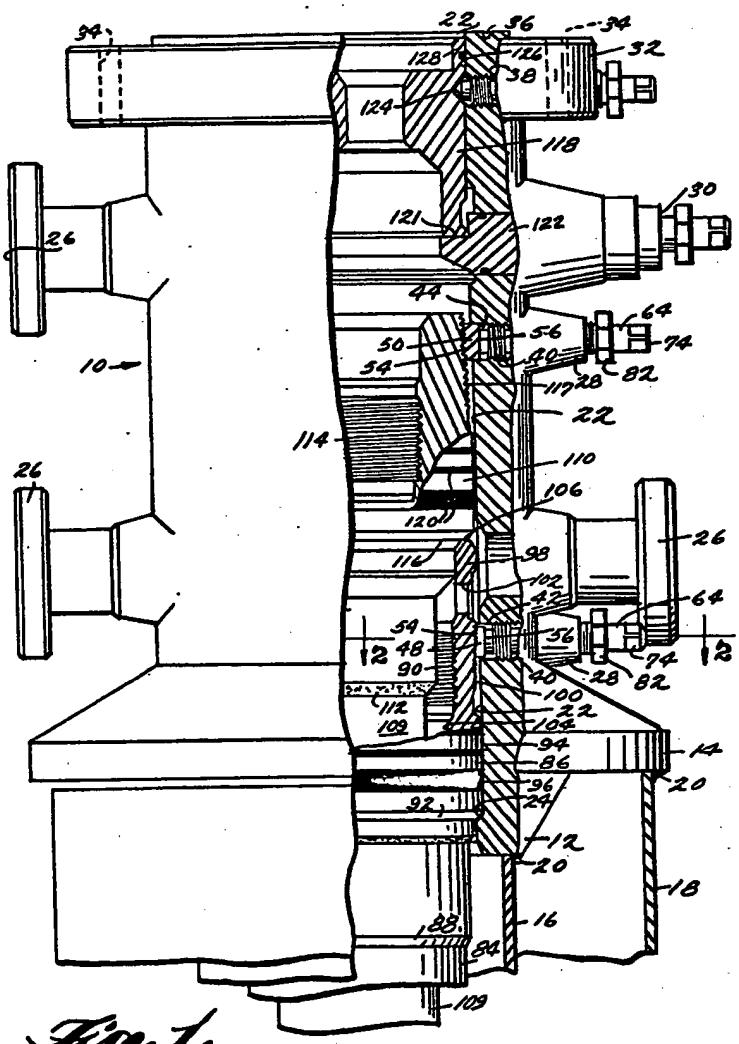

Fig. 1.

1171201 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

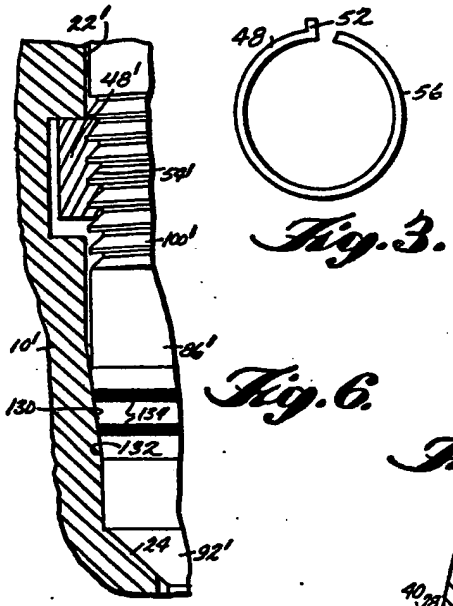

Fig. 6.

Fig. 3.

Fig. 4.

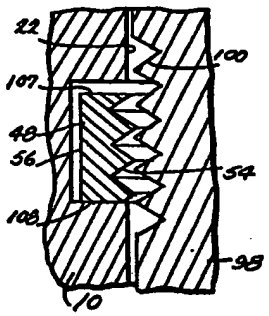

Fig. 2.

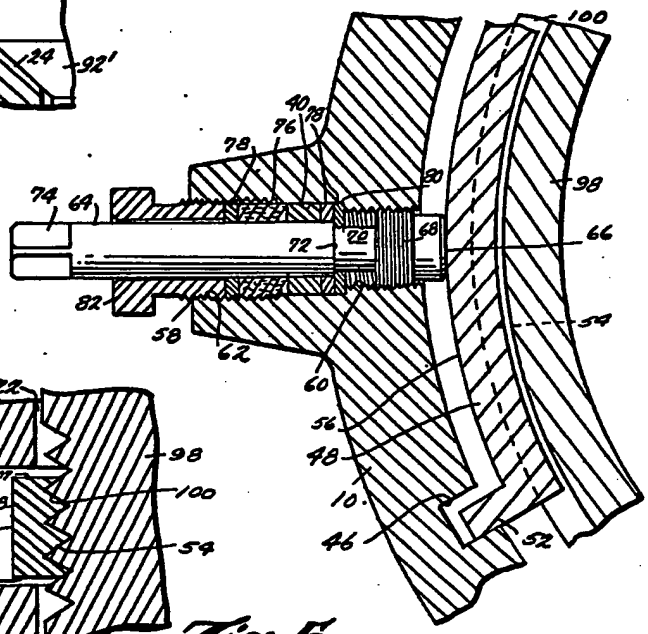

Fig. 5.